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SOME ECONOMIC AND DEMOGRAPHIC DECISIONS ON
SMALLHOLDINGS IN KENYA

by CAROLINE SWARTZ

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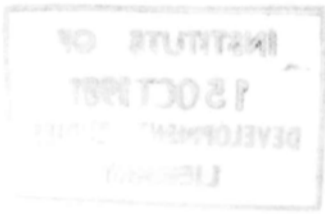
This paper details a review of research plans for investigating smallholder decisions relating to production, labor utilization and saving, employing data from the first round of the Integrated Rural Survey conducted by the Central Bureau of Statistics. Special emphasis is placed on the relevance of the research for government planning and policy making. The preliminary specification of the functions to be estimated are also identified.

Views expressed in this paper are those of the author. They should not be interpreted as reflecting the views of the Institute for Development Studies or of the University of Nairobi.

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ABSTRACT

This paper details revised research plans for investigating smallholder decisions relating to production, labor utilization and saving, employing data from the first round of the Integrated Rural Survey conducted by the Central Bureau of Statistics. Special emphasis is placed on the relevance of the research for government planning and policy making. The preliminary specification of the functions to be estimated are also identified.

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SOME ECONOMIC AND DEMOGRAPHIC DECISIONS ON SMALLHOLDINGS IN KENYA

Growth in the productivity of the rural sector is an essential part of the Kenyan development strategy. The rural areas have the capacity to feed the growing urban population, increase foreign exchange earnings and productively employ additional labor. Since the agricultural sector consists primarily of individual farmers, the extent to which agriculture realizes its potential is in part dependent on the formulation of a consistent set of government policies based on an understanding of the responses of the individual farmers to their technological and economic environment. Emphasis on aggregate growth objectives without regard to farm-level reactions can have adverse effects on several aspects of individual well-being and perhaps prevent the achievement of the aggregate goals. It is therefore essential that policies affecting the rural areas are based on a sound understanding of the farm-level decision-making process.

This research investigates the production, labor utilization and savings decisions made on smallholdings across Kenya, utilizing data from the first round of the Integrated Rural Survey conducted by the Central Bureau of Statistics. The investigation of production relationships enables an assessment of the ability of smallholdings to expand output and productively utilize relatively abundant and low cost factors of production such as labor. The labor utilization section investigates the determinants of the level of labor input, the nature of labor's interaction with other factors of production and the impact of additional household members on the amount of labor employed on the holding. The analysis of saving provides information on the level of capital formation which, in part, determines the level of output and labor utilization. The financial savings undertaken by the household is also considered since this has implications for the rate of social and private capital formation.

In addition to the information this research provides for government policy making, it also serves other purposes. The Harvard team at the Ministry of Agriculture is undertaking some analysis of similar and related issues using IRS-1 data. Where possible, the comparison of results from employing different techniques to investigate similar problems would provide information on the validity of the conclusions and the strengths of alternative approaches. In other areas, this

research will complement their findings and the results of others working with the IRS-1 data. Finally, comparisons of this and other similar studies will indicate the progress of agricultural productivity over time and the relative well-being of smallholder households.

The smallholder sector was selected for analysis since it represents a large share of arable land, of rural population and of agricultural output. Consequently, the rate of growth of agriculture and of the economy is dependent upon the behavior of the smallholders. Furthermore, the Integrated Rural Survey represents a wealth of reliable, detailed, available data for smallholders, making it possible for the results of this study to be available to the Kenyan Government to assist in drawing up the fourth Development Plan.

The initial phase of this research is designed to familiarize the researcher with the data file. This involves the computation and analysis of descriptive statistics such as frequency distributions, correlation coefficients and crosstabulations for a large number of variables related to the decisions studied. This serves two purposes. First, it provides some basic analysis of the data which is useful to government policy makers in assessing the smallholder's characteristics and decisions. Second, it enables the definition and derivation of variables for the study based on theoretical considerations and an accurate notion of what the data represent. The numerous descriptive statistics in the Basic Report on IRS-1 will not be duplicated in this study. Rather, efforts will be directed at analysis of composite variables not included in the Basic Report. The results of these investigations will be made available in a Central Bureau of Statistics publication if they are of general interest.

Investigation of the characteristics of the basic data is essential to the success of the research project. The exact formulation of the research discussed below depends on the nature of the data and the relative frequencies of the observations and so cannot be specified until this first phase of the study is completed. The main body of this paper indicates the researcher's view of the second phase of research before the first is begun. As such, these plans may require adjustments to better accommodate the strengths and weaknesses of the data. The analysis of the initial estimations will lead to the formulation of further

hypotheses and functions to be estimated and analyzed to further refine and clarify the findings. The nature of these investigations and the direction they will take also cannot be foreseen at the beginning of the research project. It is essential that research be an interactive process to ensure the validity of the results. Intermittent consultation with members of the Ministries of Finance and Planning and Agriculture to review the findings and to design the next set of investigations will ensure that the results fulfil some of their needs for information and analysis.

The final aspect of the study is the compilation of results and their analysis. A preliminary report could be available early in 1978 as an Institute for Development Studies publication. This ensures that the results are quickly available to the government for their use. The final document, to be presented as the researcher's Ph.D. thesis, will be available to interested individuals, departments and ministries of the Kenyan Government to further ensure its value in assessing the current smallholder situation and in planning.

PRODUCTION FUNCTION

The empirical investigations of the nature of the production relationships on smallholdings will consider the output of maize and the total output of the holding. As the principle staple crop, maize output is closely related to the welfare of rural residents and to the feeding of the urban population. Issues such as the relative productivity of local and hybrid maize; the economic value of fertilizer, machinery and other purchased inputs on small farms, and the identification of feasible means of encouraging increased production given the costs of various inputs and the existing resource constraints will be investigated. The implications of the analysis concern the desirability of altering technology through changing price relationships among essential inputs, increased extension assistance or by other means to increase the productivity of large numbers of smallholders.

Similar results will be derived from the analysis of the aggregate output of the holding. The overall productivity of inputs and the possibilities for substituting relatively scarce factors such as fertilizer, insecticides and machinery will receive particular emphasis. These results can be employed in the formulation of policies to encourage increased employment and increased output in the smallholder sector, thus increasing

the level of rural incomes, the equity of its distribution and further stimulating growth.

A Cobb-Douglas functional form will be employed in estimation since it has a long tradition in agricultural investigations. It is a standard functional form, easily estimated and interpreted and readily comparable to a large number of similar studies. Its demands on the data are relatively few since it does not require the same units of measure for all inputs: labor may be measured in man-day equivalents and land in acres, for example. This implies that the optimal choice of aggregation may be employed for each input, reducing bias in estimation which could result from converting all inputs to monetary values. The physical factors of production are labor, land, livestock, buildings, tools and equipment, fertilizer and other purchased inputs. Since the data is a national sample with a wide variety of soil types and ecological zones, these differences are accounted for by the use of binary variables for the different cropping zones identified by the Central Bureau as part of their data collection activities. An attempt will be made to further subdivide these zones according to cropping patterns and technology to arrive at groupings of smallholders which are more homogeneous in their production than the zones. The amount of rainfall for the area is included to control for this important environmental factor. The proportion of the workers with some education will be included to estimate the impact of education and to control for differences in the quality of workers that may be related to education.

Several relevant statistics can be derived from the Cobb-Douglas function. First, the marginal productivities of the inputs can be computed. This indicates the increment in output from a unit increase in the given input, holding the levels of all other inputs constant. One of the advantages of the Cobb-Douglas form is that the marginal productivity depends on the initial level of the input and decreases as the input level increases. Under the assumption of a well functioning market for all inputs, the ratio of the marginal product to the price of the factor should be equal for all factors if the smallholder is operating efficiently. By constructing these ratios, the efficiency of smallholder technology can be tested. Second, the elasticity of output with respect to each input can be determined. This is an indication of the percentage increase in output from a one percent increase of a given input, assuming all other input levels are constant. Third, the returns

to scale experienced by smallholders can be computed. This provides an indication of whether small farms could be productively combined or divided or if their productivity is independent of size. Finally, the marginal rates of substitution between two inputs can be found. This statistic is dependent on the levels of both inputs and indicates the quantity of one input which is required to replace one unit of another input in order to maintain constant output. This statistic is required for an assessment of the feasibility of substitution among inputs. Another useful construct is the elasticity of substitution, but unfortunately these are all constrained to be -1 in Cobb-Douglas functions. In spite of this restriction, the Cobb-Douglas function brings considerable evidence to bear on several important aspects of agricultural production.

LABOR UTILIZATION FUNCTION

The amount of labour employed on the holding is the single most variable factor of production since most of the labor is supplied by household members who can adjust their work periods as the season, weather and other factors require. Over a longer time horizon, the size of the household may also be adjusted.

One part of the solution to the employment problem in Kenya is to increase the labor intensity of agriculture with emphasis on the productive utilization of additional workers. The dual goals of increased employment and increased output can be achieved only if additional labor is productively utilized. The preceding section discusses the implications of adding more labor to smallholder agriculture with the existing levels of other inputs and technology. This section considers the labor decision within the household, focusing on factors which determine the level and distribution of the labor supplied and on the impact of an additional worker in the household on the level of labor utilization. This will indicate the likely consequences of the current rapid expansion of the agricultural labor force and provide evidence on some ways to increase productive employment.

The labor employed on the holding is a function of a disaggregated measure of household size, the physical capital of the holding, the cropping zone and the proportion of adult and child workers on the holding

with some education. Household members are divided into adults (over age 14), children (5 - 14) and young children (under age 5). Adults and children are subdivided into those working on the holding, those employed elsewhere and all others. Those working on the holding contribute directly to the labor supplied while the dependents are expected to cause the workers to increase their input. The effects of those employed off the holding are uncertain.

The inclusion of the physical capital stock in the estimation will indicate whether these assets are substitutes or complements for labor in production. This is important to an assessment of the feasibility of increasing rural incomes and employment simultaneously. It is necessary that funds are channeled into investments which require complementary inputs of labor to ensure an increase in the amount of labor absorbed by the sector. The cropping zone variables are included to represent the environmental factors which influence the types of crops grown and therefore affect the level of labor utilization.

The two education variables are included to represent the efficiency or organization of workers which would increase their productivity. Since there is some question about the effects of formal schooling on agricultural productivity, these variables are included as a further test of the hypothesized direct relationship. It will provide some information on the probable response of rural labor supply as the rural labor force and the entire population become more educated.

The major results of this investigation are two-fold: First, the disaggregated specification of household size enables an assessment of the labor utilization response to an additional individual in the household, with the response depending on the individual's age and activity. Second, the extent of the complementarity between existing capital goods and labor will be estimated. This will identify the need, if any, to formulate policies to bias investments toward capital which is labor-using in order to expand both employment and output.

In addition, some investigation into the determinants of the major economic activity of adults and children will be attempted (provided that the available software includes a discriminant analysis routine). Household characteristics such as income, household size, holding size and cropping zone, and individual characteristics such as age and

sex will be employed to identify the variables which are the most important determinants of an individual's activities.

SAVINGS FUNCTION

The level and composition of savings and therefore of capital formation are major determining factors of the ability of smallholding to increase output and to absorb labor productively. The preceding sections on production and labor utilization assumed the capital available to the holding is fixed. In the short run, the relevant time frame for production and labor decisions, this conceptualization is reasonably accurate, but as time horizons are lengthened, the assumption that capital is a fixed factor is no longer valid. Savings and investment can be regarded as subject to household decision-making in the intermediate and long run. Since capital is closely related to the level of production and labor utilization, an understanding of rural saving behavior is essential to predict or to influence future output and input levels in agriculture.

This analysis focuses on the capital formation and financial savings undertaken by the household. Physical capital formation on the holding, such as increases in the value of livestock and perennial crops, construction and repair, and the purchase of new tools is directly related to the levels of inputs and outputs of agriculture. Financial savings in the form of savings accounts or loans are of potential importance to the growth of other sectors and of the economy as a whole. Agriculture may yield the highest returns to investment in the economy; causing it to be a net debtor. In this case the loans made to smallholders are an efficient means of increasing output and GDP. Alternatively, smallholders may accumulate financial savings which can be utilized by governments for increasing social capital such as schools, health clinics or roads, or it can be utilized for private capital formation.

This investigation of savings is deficient in that it excludes human capital formation such as education which is at least in part an investment. Consideration of this form of savings is infeasible given the existing data set, however. The statistics regarding aggregate savings will be slightly underestimated as a result, but considerable valid evidence will be derived regarding physical capital formation and financial savings. The omission of this one part of savings will not invalidate the analysis of the other forms of saving. In view of the

crucial role of indigenous capital formation in the sector, it is clear that an analysis of savings is of vital importance to the character of agricultural production and future growth.

A single equation will be estimated for the sum of capital formation and financial savings. It will investigate the impact of income, the life cycle position of the household head (represented by his age and its square), the number of children and adults in the household and the physical assets currently owned by the household. The income variable includes income produced on the holding and income earned off the holding. Its coefficient indicates the proportion of an increase in income which would be saved. The life cycle hypothesis relating savings to the age of the head of household has received only tentative support in developing countries. Its inclusion here is a further test of its applicability. The household size, divided into the number of children and adults, is employed to determine the effect of an additional individual on household savings at a given level of income. Under the prevailing high levels of fertility in the rural areas and the limited possibilities for absorbing population increments in non-agricultural employment, this is an indication of future trends in rural savings. Finally, the households with relatively many assets may behave differently from those with relatively few. On the one hand, the assets are a form of wealth and could therefore enable the relatively wealthy to save more. Alternatively, an increment to an already large stock of assets is less productive than the same increment to a smaller stock, giving the relatively wealthy an incentive to consume rather than save. The investigation will produce evidence on which of these effects is dominant. If possible, each of the two main components of savings considered, physical capital formation and financial savings, will be investigated separately in equations similar to the one described for total savings. This is undertaken in view of the potentially different uses and consequences of these two forms of saving.

CONCLUSION

The preceding discussion has outlined research into the production, labor utilization and savings behavior of Kenyan smallholders. This analysis would utilize the Integrated Rural Survey data already collected by the Central Bureau of Statistics to investigate these decisions. The results would constitute a contribution to the understanding and

analysis of the nature of household and farm-level decision-making in Kenya. Furthermore, the study will produce timely information for the fourth Development Plan on ways to encourage increased output and employment in the smallholder sector.

EQUATIONS

I. Production

A. Maize Output

$$\begin{aligned} \ln QM = & a_0 + a_1 \ln LABOR_M + a_2 \ln LAND_M + a_3 \ln TOOL \\ & + a_4 \ln BUILD + a_5 \ln OTHR_M + a_6 ED + a_7 RAIN \\ & + a_8 FERT + a_9 HYB + b ZONES \end{aligned}$$

where:

- QM = gross value of maize output,
- LABOR_M = man-day equivalents of labor employed in maize production,
- LAND_M = area of land planted in maize,
- TOOL = value of tools and equipment owned by the holding,
- BUILD = value of buildings on the holding,
- OTHR_M = cost of other inputs for maize production,
- ED = proportion of workers with some education,
- RAIN = amount of rainfall in the area,
- FERT_M = binary variable = 1 if fertilizer was applied to the maize,
= 0 otherwise,
- HYB = binary variable = 1 if hybrid maize is grown,
= 0 otherwise,
- ZONES = binary variables for cropping zones.

B. Total Output

$$\begin{aligned} \ln Q = & c_0 + c_1 \ln LABOR + c_2 \ln LAND + c_3 \ln TOOL \\ & + c_4 \ln BUILD + c_5 \ln LSTOCK + c_6 \ln OTHR \\ & + c_7 ED + c_8 RAIN + c_9 FERT + d ZONES \end{aligned}$$

where:

- Q = gross value of output for the holding,
- LABOR = man-day equivalents employed,
- LAND = area of land planted or grazed,
- LSTOCK = value of livestock,
- OTHR = cost of other inputs,
- FERT = binary variable = 1 if fertilizer is employed,
= 0 otherwise,

other symbols as above.

II. LABOR UTILIZATION

$$\begin{aligned}
 \text{LABOR} = & a_0 + a_1 \text{AWH} + a_2 \text{AME} + a_3 \text{ANW} + a_4 \text{CWH} + a_5 \text{CWE} \\
 & + a_6 \text{CNW} + a_7 \text{YC} + a_8 \text{EDA} + a_9 \text{EDC} \\
 & + a_{10} \text{LAND} + a_{11} \text{TOOL} + a_{12} \text{BUILD} \\
 & + a_{13} \text{LSTOCK} + b \text{ZONES}
 \end{aligned}$$

where:

- AWH = number of adults working on the holding,
- AME = number of adults working off the holding,
- ANW = number of other adults,
- CWH = number of children working on the holding,
- CWE = number of children working off the holding,
- CNW = number of other children,
- YC = number of children under age five,
- EDA = proportion of adults in the household with some education,
- EDC = proportion of children in the household with some education,

other symbols as above.

III. SAVING

$$\begin{aligned}
 S = & a_0 + a_1 Y + a_2 A + a_3 A^2 + a_4 \text{CHILD} + a_5 \text{ADULT} \\
 & + a_6 \text{LAND} + a_7 \text{TOOL} + a_8 \text{BUILD} + a_9 \text{LSTOCK}
 \end{aligned}$$

where:

S = PK + FS,

PK = physical capital formation,

FS = financial savings,

Y = household income from all sources,

A = age of the household head,

CHILD = number of children in the household,

ADULT = number of adults in the household,

other symbols as above.

This equation will also be estimated with PK and FS as dependent variables.

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